

- [54] AIR CONTROLLED ROTARY JOINT COMPENSATOR
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- [73] Assignee: The Johnson Corporation, Three Rivers, Mich.
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- [51] Int. Cl.⁵ F16C 32/06
- [52] U.S. Cl. 384/99; 384/448; 277/1; 277/28
- [58] Field of Search 285/93, 134, 900, 132, 285/95; 277/27, 1, 28; 384/448, 99
- [56] References Cited

U.S. PATENT DOCUMENTS

- 1,896,062 2/1933 Berry .
- 2,700,558 1/1955 Hieronymus 285/10
- 3,098,665 7/1963 Smith 285/134

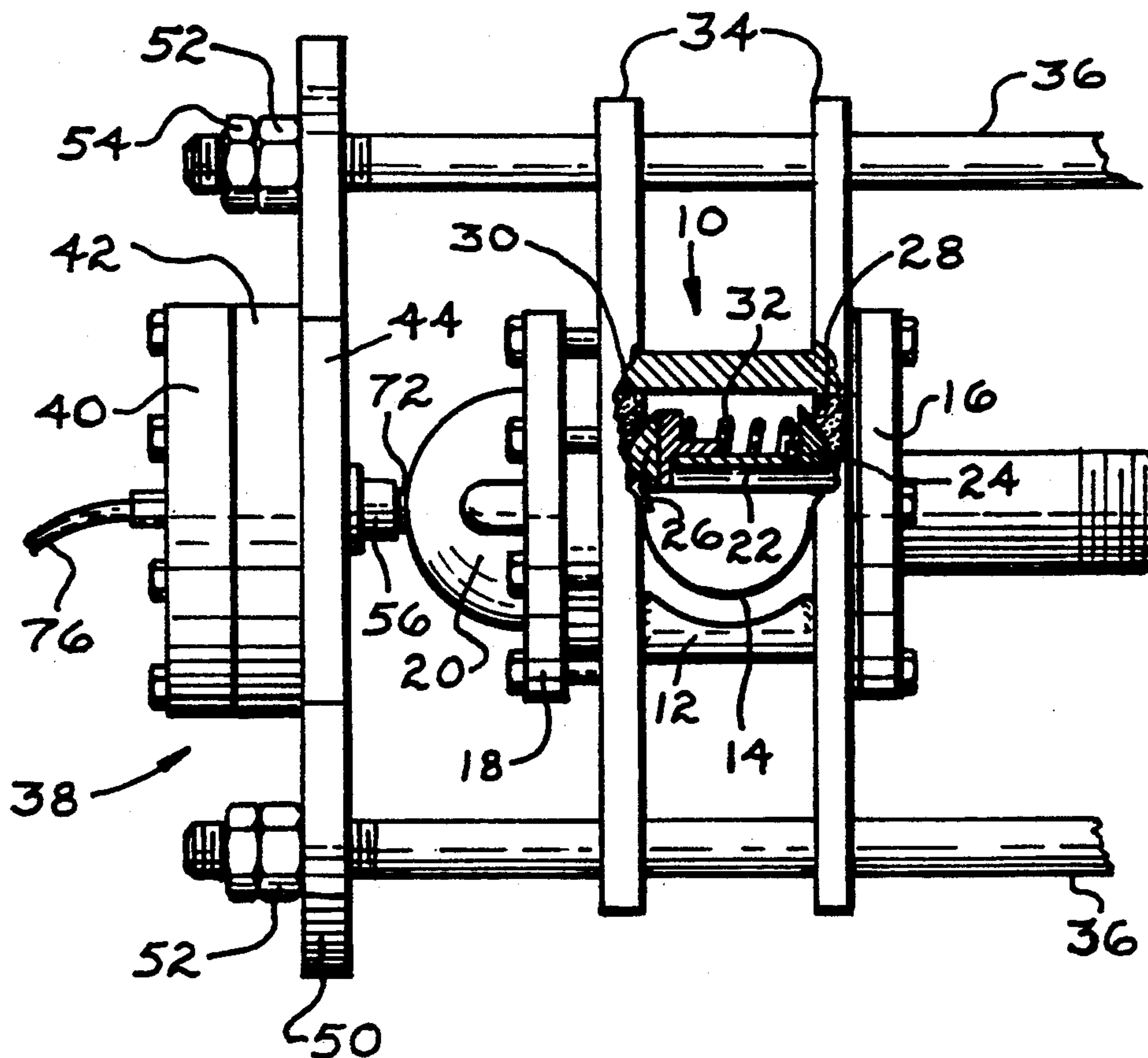
- 3,874,707 4/1975 Calkins 285/93
- 4,533,147 8/1985 Sondo et al. 277/28 X
- 4,722,534 2/1988 Wentworth 277/28
- 4,836,693 6/1989 Strozic 384/448 X
- 4,915,510 4/1990 Arvidsson 384/448 X

Primary Examiner—Dave W. Arola
 Attorney, Agent, or Firm—Beaman & Beaman

[57] ABSTRACT

The invention pertains to the method and apparatus of compensating for the axial bearing load forces imposed upon rotary joints conveying a pressurized fluid medium, such as steam, by imposing an axial force on the rotary joint housing proportional to the pressure within the rotary joint by use of a distinctively different pressurized medium than that conveyed by the joint, such as compressed air. An expansible chamber motor capable of imposing an axial force on the rotary joint utilizes compressed air whose pressure is controlled by a sensing and regulating system responsive to the pressure within the rotary joint.

4 Claims, 1 Drawing Sheet



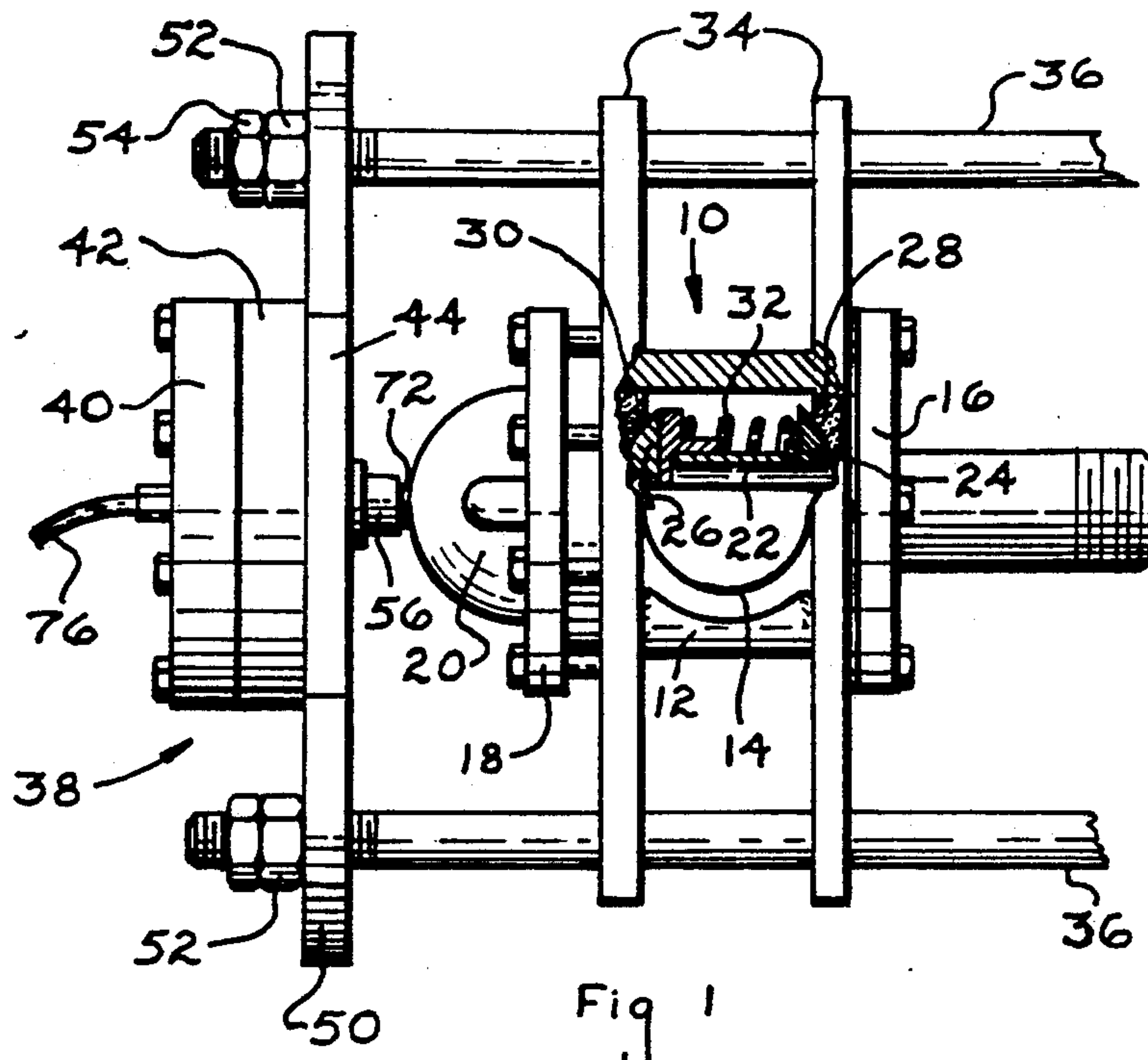


Fig 1

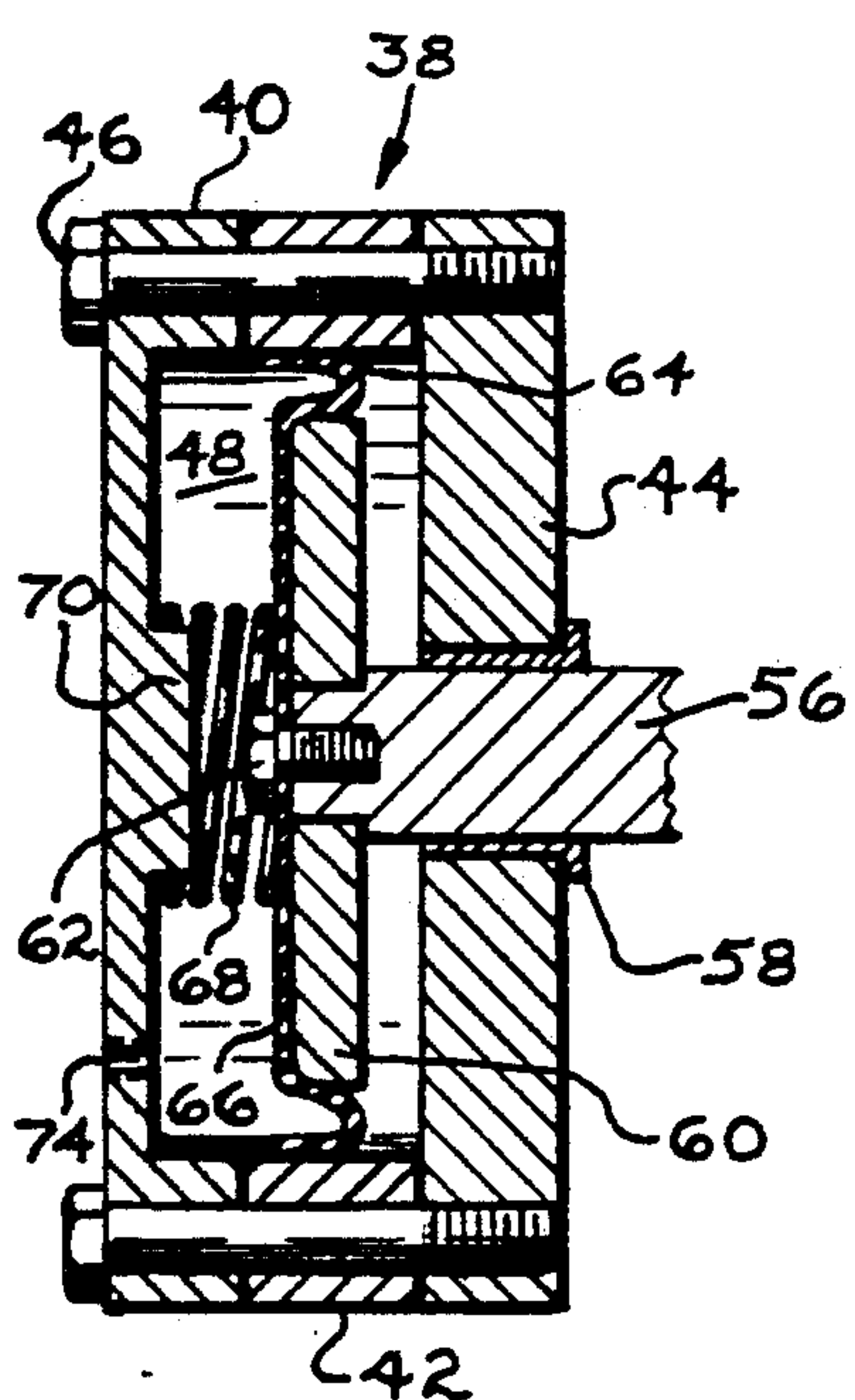


Fig 2

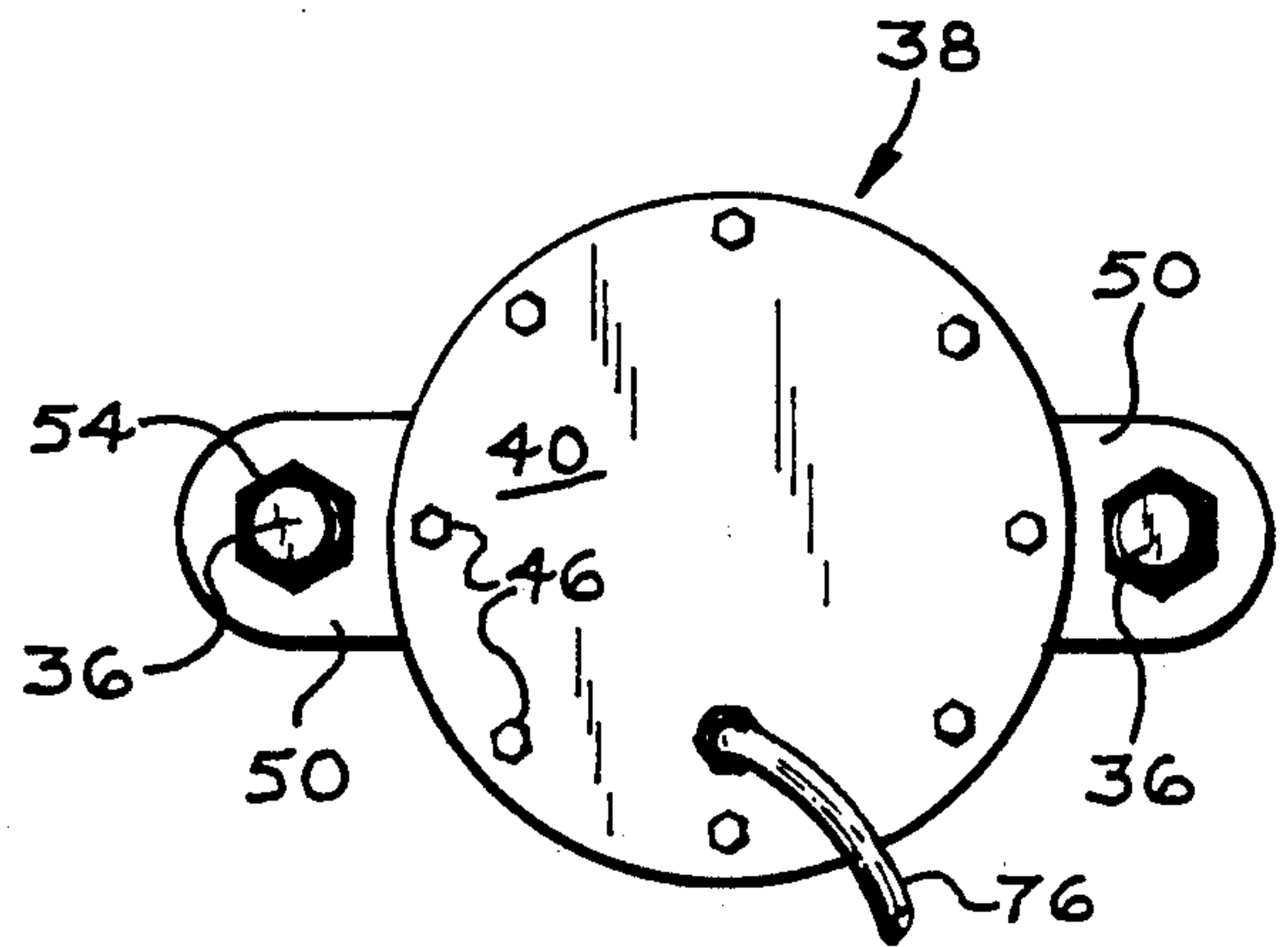


Fig 3

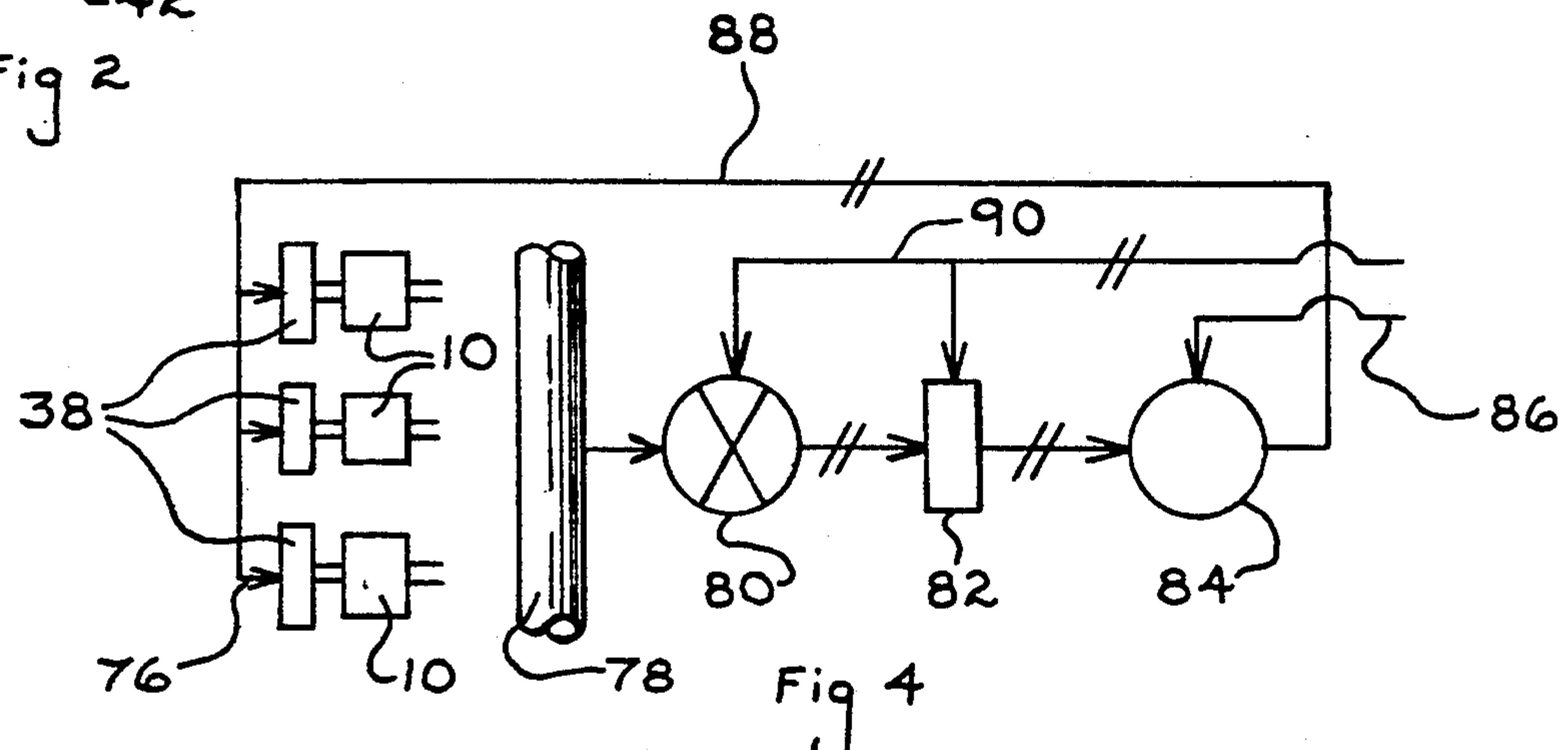


Fig 4

AIR CONTROLLED ROTARY JOINT COMPENSATOR

This is a division of application Ser. No. 07/351,465 5
filed on May 15, 1989, now U.S. Pat. No. 4,971,367,
issued Nov. 20, 1990.

BACKGROUND OF THE INVENTION

Rotary joints are employed to introduce a heat ex- 10
changing fluid medium into a heat exchanger drum, or
remove the medium from the drum. Such joints are
widely used in the paper and fabric industries for drying
a web rapidly moving over the drum surface, and the
most common heat exchanging medium utilized is 15
steam. If the drum is used for cooling purposes the
rotary joint may convey water.

Typical rotary joints include a housing rotatably
mounted upon a nipple concentric to the drum axis of
rotation and rotating therewith. Annular seals inter- 20
posed between the joint housing and the nipple produce
a fluid-tight sealing, and as the seals are mounted within
the rotary joint housing the seals are exposed to the
internal pressure within.

The pressure within the rotary joint tends to bias the 25
seals against the sealing areas and such forces cause the
seal pressures to be excessive accelerating seal wear and
increasing the seal friction which elevates the seal tem-
perature further increasing wear.

Several approaches have been utilized with rotary 30
joint construction to minimize excessive seal wear due
to seal pressure produced by the pressurized medium
being conveyed. Internal selfcompensating joint con-
structions use designs wherein the seal faces exposed to
the internal pressures substantially counteract each 35
other to reduce seal wear. Also, external self-compen-
sating apparatus is used with rotary joints to impose an
axial force on the joint housing itself to reduce seal wear
and typical examples of this type of external compensa-
tion are shown in U.S. Pat. Nos. 1,896,062; 2,700,558; 40
3,098,665 and 3,874,707.

In known externally compensated rotary joint sys-
tems an expansible chamber motor is axially fixed with
respect to the rotary joint housing which is axially dis-
placeable, and the motor is concentrically located with 45
respect to the axis of rotation of the drum nipple and
rotary joint housing. The interior of the joint housing
directly communicates with the interior of the expansi-
ble chamber motor which includes a piston, or piston
structure, engaging the housing. As the compensating 50
force exerted on the housing by the expansible chamber
motor equals the pressure within the housing times the
piston area of the motor the degree of compensation
achieved is always proportional to the pressure within
the rotary joint housing, and the degree of compensa- 55
tion achieved is a fixed percentage of the housing pres-
sure as determined by the area of the piston within the
compensating expansible chamber motor. Thus, due to
the "fixed" ratio of compensation it is not possible to
vary the compensation once the equipment is installed 60
and the degree of compensation can only be varied by
making major mechanical changes, such as by utilizing
different sizes of pistons.

Expansible chamber motors of the external types used
for compensating rotary joints either use pistons having 65
O-rings for sealing purposes, or the pistons are of a
metal diaphragm type. Both piston arrangements create
problems. Pistons utilizing O-rings seals limit the use of

the compensator with respect to high steam pressures
due to the temperature limitations of the material of the
O-ring as O-ring materials quickly deteriorate at ele-
vated steam temperatures. Diaphragm type piston
structures have limited axial travel due to the inherent
nature of construction of the metal diaphragm, and as
bearing wear occurs and increased piston movement is
required for compensation adjustments must be made in
view of the limitations of metal diaphragm pistons.

The concepts of the invention overcome the afore-
described limitations of known external rotary joint
compensators.

It is an object of the invention to provide an external
load bearing compensator for rotary joints wherein
previous problems encountered with the piston struc-
ture of prior compensating expansible chamber motors
are eliminated.

Another object of the invention is to provide an ex-
ternal self-compensator for rotary joints utilizing an
expansible chamber motor wherein the pressurized me-
dium within the expansible chamber motor is a separate
medium from that within the rotary joint, and the ex-
pansible pressurized medium is not at an elevated tem-
perature and is non-corrosive.

An additional object of the invention is to provide an
external self-compensator for rotary joints wherein the
degree of compensation can be easily and accurately
varied for each rotary joint without requiring structural
modifications.

Yet a further object of the invention is to provide an
external self-compensator for rotary joints wherein high
pressure steam is within the joint housing and com-
pressed air is employed to produce the compensating
forces upon the rotary joint.

In the practice of the invention the basic structural
arrangements previously utilized with conventional
externally compensated joints are employed. For in-
stance, the rotary joint includes axially displaceable
bearings to seal the housing interior with respect to the
rotary drum mounted nipple upon which the housing is
mounted. The housing is mounted for limited axial dis-
placement. An expansible chamber motor includes pis-
ton structure coaxial with the joint housing axis of rota-
tion and is axially fixed and engages the housing
whereby displacement of the piston axially displaces the
rotary joint housing.

However, rather than the chamber of the expansible
chamber motor directly communicating with the inte-
rior of the rotary joint housing as is the usual practice,
the expansible chamber motor receives compressed air
having a controlled pressure. The compressed air re-
ceived by the expansible chamber motor is controlled
by sensing and regulating means which senses the pres-
sure within the rotary joint by sensing the pressure
within the header supplying steam or other pressuring
medium to the rotary joint. Accordingly, it will be
appreciated that the pressurized medium being supplied
to the rotary joint differs from that being supplied to the
compensating expansible chamber motor.

A transmitter is used to sense the pressure within the
steam header, or within the rotary joint housing. This
transmitter controls multiplying and amplification appa-
ratus which regulates the pressure of compressed air
supplied to the compensating expansible chamber mo-
tor. The multiplying and amplifying apparatus may be
very easily regulated to accurately control the pressure
within the compensating expansible chamber motor,
and in this manner the compensation of each rotary

joint may be "customized", i.e. the axial force imposed upon each rotary joint may be very accurately regulated to compensate for the individual characteristics of that particular rotary joint.

As the pressurized medium being supplied to the compensating expansible chamber motor is clean, cool compressed air the expansible chamber piston may include an elastomeric diaphragm to provide one hundred percent sealing between the piston and the cylinder wall of the expansible chamber motor, and the diaphragm may be so constructed as to provide sufficient axial piston movement without necessitating adjustment throughout the entire compensating range as the seals wear. The use of compressed air eliminates the previously experienced corrosion and deterioration of seal material, and piston structure utilizing a high temperature elastomer and fabric will provide effective sealing for a long period of time while permitting extensive piston movement during compensation.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned objects of the invention and the advantages thereof will be appreciated from the following description and accompanying drawings wherein:

FIG. 1 is a plan view of a typical rotary joint and external compensator installation in accord with the invention, a portion of the rotary joint housing being broken away for purpose of illustration,

FIG. 2 is an enlarged, diametrical, elevational sectional view of the compensating expansible chamber motor of the invention,

FIG. 3 is an end view of FIG. 1 as taken from the left thereof, and

FIG. 4 is a schematic diagram illustrating the basic components of the apparatus used to practice the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A typical arrangement of a rotary joint having an external compensator is shown in FIG. 1, and this arrangement is very similar to that shown in the assignees U.S. Pat. No. 3,874,707.

The rotary joint is generally indicated at 10 and includes a housing 12 having a conduit inlet port 14. The housing includes an inner wall plate 16 attached to the housing by bolts, and at its other axial end the housing is closed by the outer wall plate 18 also attached to the housing by bolts. The housing wall 18 also includes a syphon housing 20 whereby syphon structure, not shown, may communicate the housing 12.

Internally, the housing 12 is mounted upon the rotating tubular nipple 22 which is coaxially connected to the rotating heat exchanger drum for rotation therewith, not shown, receiving the pressurized medium introduced into the rotary joint 10 through the inlet port 14. Sealing structure is located within the housing 10 interposed between the nipple 22 and the housing and such seals are of an annular configuration including collars 24 and 26 which, at least one of which may be axially displaceable on the nipple and an annular sealing ring 28 is located between collar 24 and inner wall 16 while the annular seal 30 is located between collar 26 and outer wall 18. A compression spring 32 biases the collars 24 and 26 into engagement with the associated sealing ring and sealing surfaces exist between the collars and their associated sealing rings, and between the

sealing rings and their associated housing end wall plates.

As will be appreciated, as the housing sealing structure is directly exposed to the pressurized medium, usually steam, within the housing 10 significant internal pressures exist within the housing that are also imposed upon the sealing structure causing the engaging surfaces of the seals and collars to firmly engage.

The rotary joint housing 10 is supported upon a pair of radially extending arms 34 which have holes at their outer ends for slidable association with the support rods 36 which are attached to fixed support structure adjacent the rotary drum, not shown. The support rods 36 are threaded at their outer ends for providing support for the compensating external expansible chamber device or motor 38 as later described. The aforesaid rotary joint structure is known and fully described in the assignees U.S. Pat. No. 3,874,707.

The construction of the compensating expansible chamber motor 38 is best appreciated from FIG. 2. The compensator comprises an expansible chamber motor 38 having a housing defined by an outer cover plate 40, an annular spacer plate 42, and a body plate 44. These three plates are maintained in assembled relationship by eight threaded bolts 46 having heads bearing against the cover plate 40, and threads which thread into holes defined in the body plate 44. As will be appreciated from FIG. 2, plates 40 and 42 are each provided with an internal cylindrical surface of equal diameters to define the cylindrical chamber 48 of the compensator motor.

The plate 44 includes a pair of radially extending arms 50 having threaded nuts 52 affixed thereto and by the use of lock nuts 54, the axial position of the compensator motor 38 to the support rods 36, and to the joint housing 12, can be accurately determined and maintained. It is to be appreciated that the rotary joint arms 34 are supported upon the support rods 36 for axial displacement of the housing 12 relative thereto, while the compensator 38 is axially fixed with respect to the support rods and the joint housing.

The compensator 38 includes a piston 56 axially extending through the center of the body plate 44 through a bushing 58, and internally, a circular rigid head 60 is mounted upon the piston by bolt 62. A flexible diaphragm 64 formed of a high temperature resistant elastomer and fabric, such as commercially known under the trademark Viton, is mounted upon the piston head by a lip retainer 66 held in position by the bolt 62, and at its outer region the flexible diaphragm is received between the joining surfaces of the cover plate 40 and the spacer plate 42 so that the outer circumference of the diaphragm is sealed with respect to the compensator housing. A compression spring 68 circumscribing to the boss 70 formed on the cover plate and bears against the lip retainer 66 to bias the piston head and piston to the right, FIG. 2, into engagement with the anvil 72 defined on the rotary joint syphon housing 20.

An inlet port 74, FIG. 2, is formed in the cover plate and is tapped with a $\frac{1}{4}$ " pipe thread for receiving the air supply tube 76, FIG. 1.

With reference to FIG. 4, the circuitry and operation of the external rotary joint bearing compensator of the invention will be explained.

The pressurized medium, such as high temperature steam, supplied to the rotary joint 10 through the port 14 is supplied from a header 78. A transmitter 80 is in communication with the header 78 sensing the pressure within the header. The transmitter 80 produces a signal

proportional to the pressure within the header and this signal is transmitted to the multiplier 82. The multiplier 82 in turn produces a signal fed to the amplifying relay 84 which is in the form of a compressed air regulator receiving compressed air through supply conduit 86. The pressure of the compressed air from the regulator 84 is determined by the signal received from the multiplier 82, and the regulated compressed air is supplied through conduit 88 to the compensator expansible chamber motor 38 through tube 76, and accordingly, the pressure within the compensator chamber 48 will be determined by the regulator 84 and the axial force imposed on the rotary joint housing 12 by the piston 56 is accurately determined by the value of the compressed air within the compensator 38. In FIG. 4 a plurality of compensators 38 are shown as being controlled in parallel by the compressed air from regulator 84, and it will be appreciated that a plurality of rotary joints 10 may be controlled by a single regulator or each rotary joint may have its own regulator.

It will be appreciated from the above description that the compressed fluid medium used to control the compensator expansible chamber motor 38 is separate and distinct from the pressurized fluid medium within the header 78 and joint 10. As the preferred control pressurized medium is compressed air, and as compressed air will be relatively cool, no significant deterioration of the flexible diaphragm 64 will occur due to the compensator medium, and as will be appreciated from FIG. 2, the "fold" of the diaphragm may be significantly long to permit sufficient piston travel to accommodate the entire range of movement required for compensation as the seals wear without necessitating adjustment of the compensator upon the support rods 36.

In the disclosed control circuitry shown in FIG. 4 the transmitter 80 and multiplier 82 are air controlled, and compressed air is supplied to the transmitter and multiplier through the compressed air conduit 90. The transmitter 80 may be a FOXBORO pressure transmitter and the multiplier may also be a FOXBORO pneumatic computer multiplier while the amplifying relay regulator may be a standard model manufactured by Moore Products. As the transmitter 80 receives a steam pressure signal from the header the transmitter produces an air pressure signal corresponding to the steam pressure and the pneumatic computer multiplier 82 produces an air pressure signal proportional to the amount of compensation force needed. This air pressure signal from the multiplier 82 is then supplied to the amplifying relay regulator 84 where it is boosted to provide the necessary pressure for the compensator 38. While, in the enclosed embodiment, the sensing and control of the air pressure supplied to the compensator utilizes air controlled devices, it will be appreciated that electronically operated transmitter and multiplier devices may be used and the amplifying relay would constitute an electrically controlled compressed air regulator.

The computer multiplier 82, or transmitter 80, or both, include readily adjustable controls so that the air pressure supplied to or through the conduit 88 may be very accurately regulated merely by adjusting such controls. Thus, the practice of the invention permits the amount of load bearing compensation of the rotary joints to be very accurately regulated to accommodate the particular conditions present.

To obtain maximum seal ring life the force exerted on the seal rings 28 and 30 and the temperature of the seal rings must be maintained at a minimum. However, the

axial sealing force on the seal rings must be sufficient to produce effective sealing. Excessive force on the seal rings causes faster than normal wear and high temperature cause rapid deterioration. The axial force on the seal rings is determined by the pressure of the medium within the rotary joint, and the temperature of the seal rings is determined by both the temperature of the medium within the joint and the heat generated by contact between the seal rings and the associated collars and plates. While the temperature of the medium within the joint cannot be regulated, the degree of seal friction can be controlled by the compensation provided by the practice of the invention, and by regulating the output signals of the transmitter and multiplier the degree of axial compensating force imposed on a rotary joint may be very accurately regulated and varied if desired. Such "customized" adjustment has not been previously available with either external or internal compensated rotary joints.

By utilizing compressed air as a control pressurized medium for the compensator expansible chamber motor problems previously encountered due to condensate within the expansible chamber motor compensating motor are eliminated, the seal structure within the compensator is not exposed to high temperatures, and sufficient axial piston movement can be achieved with 100% effective sealing between the piston and chamber by the use of the diaphragm is present as compared to the limited metal diaphragm movement of prior art devices, and with the practice of the invention the ability of an exteriorly compensated rotary joint to handle nonconcentric installations is maintained while simultaneously providing a degree of control of compensation not heretofore achievable.

It is appreciated that various modifications to the inventive concepts may be apparent to those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. The method of compensating the axial loading on the bearings of a rotary joint supplying stem to a drum having an axis of rotation wherein the interior of the joint, the bearings and the drum are subjected to pressurized steam, steam being supplied to the rotary joint by a header, and the rotary joint including a bearing axial load compensating expansible chamber comprising the steps of:

- (a) sensing the pressure of the steam within the header, to produce a control signal,
- (b) providing a source of compressed air,
- (c) controlling the pressure of said compressed air with said control signal, and
- (d) introducing said controlled compressed air into the rotary joint expansible chamber to impose an axial force on the rotary joint proportional to said control signal to regulate the axial load on the rotary joint bearings as determined by the pressure of the steam within the header.

2. The method of compensating the axial loading on the bearings of a rotary joint as in claim 1 including the step of amplifying said control signal.

3. The method of compensating the axial loading on the bearings of a rotary joint having an axis of rotation wherein the interior of the joint and the bearings are subject to pressurized steam comprising the steps of:

- (a) providing a source of compressed air,

7

- (b) sensing the pressure of the steam within the rotary joint to produce a compressed air control signal proportional to the steam pressure,
- (c) regulating the air pressure by said compressed air control signal to produce a compressed air control pressure proportional to the steam pressure, and
- (d) utilizing said compressed air control pressure to impose an axial force on the rotary joint propor-

8

tional to said compressed air control signal to regulate the axial load on the rotary joint bearings as determined by the pressure of the steam.

- 4. The method of compensating the axial loading on the bearings of a rotary joint as in claim 3, including the step of amplifying said compressed air control signal.

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